# Impact of slash disposal on soil and water loss and the growth of planted seedlings

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**Abstract:** The three methods of slash disposal in this experiment were no treatment, strip piling and burning. The results obtained from this study showed that the soil erosion, water and nutrient loss were higher in the logged areas by burning than in the logged areas by no treatment and strip piling. The soil and water loss was not serious when the slope degree of the logged area was less than 16°. The survival rate of planted seedlings was higher and the growth was better in the logged areas followed by burning than in the logged areas by no treatment and strip piling. Burning should not be used when the slope was more than 23°

**Key words**: Slash disposal; Soil and water loss; Seedling growth.
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## Introduction

State Forestry Administration of China issued management investigated for forest harvesting and regeneration in 1987, which included three methods of slash disposal (State Forestry Administration 1987). The first slash treatment is slash piling, which is divided into scattered piling and strip piling. The scattered piling is suitable for selection cutting, strip cutting and tending cutting. Strip piling is used following clear cutting. The second slash treatment is spreading of slash. The third is slash burning; which is used after clear cutting followed by artificial regeneration. These slash disposal methods will affect, in varying slope degrees, soil and water loss and seedling growth in logged areas. This paper studies only strip piling and burning. The check plot is the logged area with no treatment.

## Experimental plots

The experimental plots were in the Jinsong Forestry Farm of Baihe Forestry Bureau in Changbai Mountain forest district. It is located at 48°01 'N and 128°04'E. The elevation is 1 763 m, and the rainy season is from June to September with 490 mm annual precipitation (Fig. 1) (Zhang 1981). The soil is dark brown forest soil. The experiment plots were set in the clear-cut areas of the coniferous and hardwood mixed forest. Five slope grades (5°, 8°, 16°, 23°, 30°) were selected. Fifteen runoff plots were created (Table 1). The experiment was conducted from June to September of 1990.

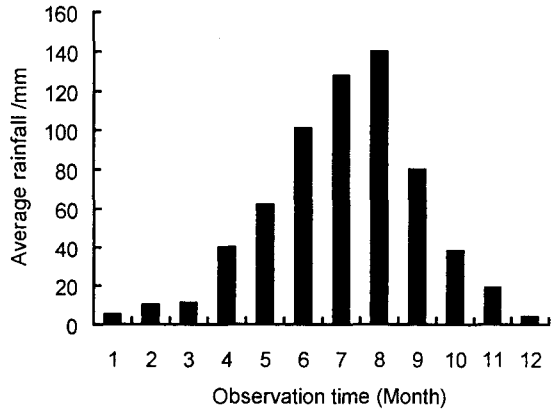


**Fig. 1. The average monthly rainfall in Baihe district of Changbai Mountain**

## Results and analyses

### Impact of the different clearing methods on the soil and water loss

Table 2 shows that the amount of annual runoff from the logged area after burning was 1 721 $m^3 \cdot hm^{-2}$ and after strip piling was 236 $m^3 \cdot hm^{-2}$. They were 11.6 and 1.54 times that of check plots respectively.

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The annual average amount of soil erosion after burning was 15 794 kg·hm$^{-2}$ and after strip piling was 324 kg·hm$^{-2}$. They were 81.2 and 1.67 times that of check plots respectively. The logged areas after burning lose the slash for intercepting rainfall. The soil and water loss from the exposed logged area is increased.

### Nutrient loss

From Table 2, the organic matter total N, total P and total K lost very serious in burned areas. In strip piled areas, the loss was smaller. The great loss of organic matter and nutrients will certainly lead to the soil degradation of logged areas.

### Seasonal changes in the soil and water loss

From Table 3 and Table 4, the soil and water loss mainly emerged from June to September. The loss was most serious in August, and was 31% of the annual loss. During this time, the precipitation intensity was greater, the rainfall was higher and the soil was frequently saturated. Therefore runoff accrued easily. The soil erosion was very serious in burned areas. The soil erosion following strip piling and no treatment was obvious. In the Changbai Mountain district, the freeze-up period is from October to May of next year, thus soil and water loss does not happen during this period.

**Table 1. Survey of experimental plots**

| Sites | Order of plots | Methods of Slash disposal | Design slope | Actual slope degree |
|---|---|---|---|---|
| | 1 | None | | 5°21' |
| 1 | 2 | Strip piling | 5° | 5°03' |
| | 3 | Burning | | 4°52' |
| | 4 | None | | 8° 35' |
| 2 | 5 | Strip piling | 8° | 8° 54' |
| | 6 | Burning | | 9° 28' |
| | 7 | None | | 15°58' |
| 3 | 8 | Strip piling | 16° | 16°51' |
| | 9 | Burning | | 17°08' |
| | 10 | None | | 22°05' |
| 4 | 11 | Strip piling | 23° | 23°0' |
| | 12 | Burning | | 22°41' |
| | 13 | None | | 29°05' |
| 5 | 14 | Strip piling | 30° | 30°11' |
| | 15 | Burning | | 30°52' |

**Table 2. The amount of nutrient loss of soil and water by different slash disposal methods**

| Slash disposal method | Runoff /m$^3$·hm$^{-2}$ | Soil erosion /kg·hm$^{-2}$ | Nutrients /kg·hm$^{-2}$ | | | |
|---|---|---|---|---|---|---|
| | | | Organic matter | Total N | Total P | Total K |
| None | 152.82 | 194.50 | 24.50 | 0.73 | 0.43 | 15.6 |
| Strip piling | 235.58 | 324.34 | 78.12 | 1.25 | 0.72 | 52.1 |
| Burning | 1 721.43 | 15 793.51 | 412.51 | 15.24 | 6.52 | 315.2 |

**Table 3. Monthly changes of soil erosion by slash treatment (1990)**

| Slash treatment | Soil erosion /kg·hm$^{-2}$ | | | |
|---|---|---|---|---|
| | June | July | August | September |
| None | 35.4 | 37.8 | 65.2 | 42.5 |
| Strip piling | 68.4 | 69.8 | 116.3 | 55.5 |
| Burning | 2 154.3 | 4 080.5 | 4 875.2 | 2 857.6 |

**Table 4. Monthly runoff changes by slash treatment (1990)**

| Slash treatment | Soil erosion /km$^3$·hm$^{-2}$ | | | |
|---|---|---|---|---|
| | June | July | August | September |
| None | 28.6 | 42.4 | 42.5 | 21.5 |
| Strip piling | 27.6 | 63.4 | 87.5 | 23.7 |
| Burning | 224.3 | 410.5 | 487.5 | 279.0 |

### Impact of slope degree

The soil and water loss for five slope classes showed in Table 5. The impact of the slope grades on the soil and water loss was complicated. The soil and water loss did not continually increase with the increasing slope degree. The change of slope degree has a limit. When the slope degree goes beyond the limit, the soil and water loss will not increase and may eventually decrease. Table 5 showed that the slope degree limit was about 23°. Chen Yongzong (1988) considered a critical slope degree for soil and water loss. When the slope degree was more than the critical slope degree, runoff and soil erosion tend to decrease with increasing slope degree, soil texture, rainfall and other conditions.

Table 5 showed the amount of annual soil erosion of each slope class in burned areas greatly exceeded the background erosion (1 800 kg·hm$^{-2}$·a$^{-1}$) (Chen 1988). The amount of soil erosion following no treatment and strip piling was less than 1 800 kg·hm$^{-2}$·a$^{-1}$ The amount of annual soil erosion from burned areas was 26 542 kg·hm$^{-2}$·a$^{-1}$ and 25 268 kg·hm$^{-2}$·a$^{-1}$ respectively, when the slope degree was 23°-30°. These numbers reached the mid-erosion level (25 000-50 000 kg·hm$^{-2}$·a$^{-1}$)(Chen 1988). The soil on slope degree less than 16° had light erosion. There was little erosion for slope degree was less than 8°.

The above analyses showed that burning on slope degree less than 16° would not lead to serious soil and water loss. Burning should be forbidden when the slope degree exceeds 23°.

**Impact of different slash disposal methods on the growth of planted seedlings**

Korean larch seedlings were planted in the experimental plots in the spring of 1991. The survival rate was investigated in March of 1994 (Fig.2).

**Table 5. The relationship between soil and water loss in different slope degrees**

| Slope degree ( ° ) | Annual loss (1990) | | | | | |
|---|---|---|---|---|---|---|
| | Water /$m^3 \cdot hm^{-2}$ | | | Soil /$kg \cdot hm^{-2}$ | | |
| | No treatment | Strip piling | Burning | No treatment | Strip piling | Burning |
| 5 | 96.3 | 110.2 | 510.8 | 90.5 | 112.5 | 3 580.7 |
| 8 | 91.4 | 125.4 | 698.1 | 92.6 | 146.8 | 7 126.4 |
| 16 | 143.2 | 240.8 | 1 808.4 | 172.7 | 346.9 | 1 9210.6 |
| 23 | 232.4 | 362.1 | 2 901.5 | 305.8 | 510.6 | 26 542.0 |
| 30 | 200.7 | 340.5 | 2 687.6 | 311.1 | 496.5 | 25 268.1 |

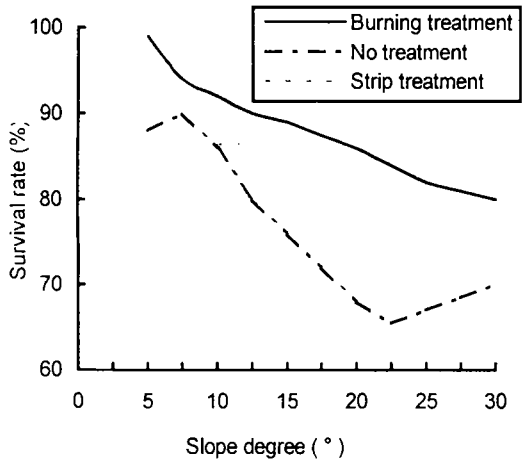


**Fig. 2. The survival rate of planted seedlings under different slash treatments**

**Table 6. The height growth of Korean larch seedlings in different years**

| Slash treatment | Height growth /cm | | |
|---|---|---|---|
| | 1991--1992 | 1992--1993 | 1993-1994 |
| None | 41 | 53 | 57 |
| Strip piling | 43 | 58 | 62 |
| Burning | 57 | 73 | 68 |

Fig. 2 showed that the survival rate of planted seedlings was highest after burning. The average value was 87.6 %. The survival rate after no treatment and strip piling was 77 % and 78 % respectively. The survival rate decreased as slope degree increased. The survival rate with no treatment was lowest, only 62 %. Consequently burning can increase the survival rate of planted seedlings. The reasons are that the first, burning prevents a lot of weeds and bushes, which compete with seedlings for nutrient and moisture. The second is eliminating plant diseases and insect pests.

The investigation showed that the height growth of Korean larch seedlings in burned areas was higher than others, especially the first and the second year after burning (Table 6). The increment of the seedling height is very obvious, the incremental rates were 39 % and 37.7 % respectively. The increment of the third year (1993-1994) decreased to 19.3 %. The reasons may be that the quick-acting nutrients of soil increased in varying slope degrees after burning. The breeding of weeds led to declining of the incremental rate of seedling height in the third year.

## Conclusions

The experiment showed that no treatment was the best one of three slash disposal methods for preventing the soil and water loss. The soil and water loss of the all three slash disposal methods would increase along with the increasing slope degree in the logged areas. The soil and water loss with burning was lower when the slope degree in logged areas was less than 16°. When the slope degree was more than 23°, the loss was very serious, and burning should be forbidden. For increasing the survival rate of planted seedlings, burning was the best of the three slash disposal methods and is recommended when slope degree was less than 16°.

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